



EFFICIENT URBAN GREEN MANAGEMENT TOOLS FOR ADAPTATION TO CLIMATE CHANGE

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Kraków
Municipal Greenspace
Authority

ProGea^{4D}



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ISA
MALMÖ 22



With the contribution of the LIFE Programme of the European Union. LIFE17 CCA/IT/000079

Project coordination



Paolo Viskanic

CEO of R3 GIS

Degree in Tropical and Subtropical
Agriculture

Project Coordinator LIFE
UrbanGreen



Software company specialized in environmental platforms for smart cities

Team of 20 people, based in Bolzano, South Tyrol, Italy

Operating in Italy, Austria, Germany, Switzerland, Poland, Finland, Slovenia,
Hungary, Taiwan

Vision

Help cities around the world to manage their green infrastructure efficiently and safely to improve the quality of life and help them to adapt to the effects of climate change.



The LIFE URBANGREEN Project



The LIFE programme

European funding instrument to support projects focused on



Environment sub-programme

- Nature and biodiversity
- Environment and resource efficiency
- Environmental governance and information



Climate action sub-programme

- Climate change mitigation
- Climate change adaptation
- Climate governance and information

LIFE URBANGREEN

INNOVATIVE TECHNOLOGICAL PLATFORM TO IMPROVE
MANAGEMENT OF GREEN AREAS FOR BETTER CLIMATE
ADAPTATION



R3GIS
managing spaces

Kraków

ProGea^{4D}



Kraków
Municipal Greenspace
Authority

Rimini

Anthea



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DI MILANO

€ 2.5 M Total budget
€ 1.3 M EU contribution

07/2018

12/2021



Three main project pillars

RESEARCH



- Leaf transpiration measurements
- Pollutant deposition analysis
- LiDAR survey
- Meteo data analysis
- IOT sensors integration
- Satellite data analysis

SOFTWARE TOOLS



- Ecosystem services calculation
- Meteo data integration
- Smart irrigation tool
- IOT sensors integration
- Improved job planning
- Public portal for citizens

TEST ON PILOT SITES



Test new tools and assess effect of best practices on trees:

- Target pruning
- Irrigation
- Soil decompaction
- Mulching

Sites and species

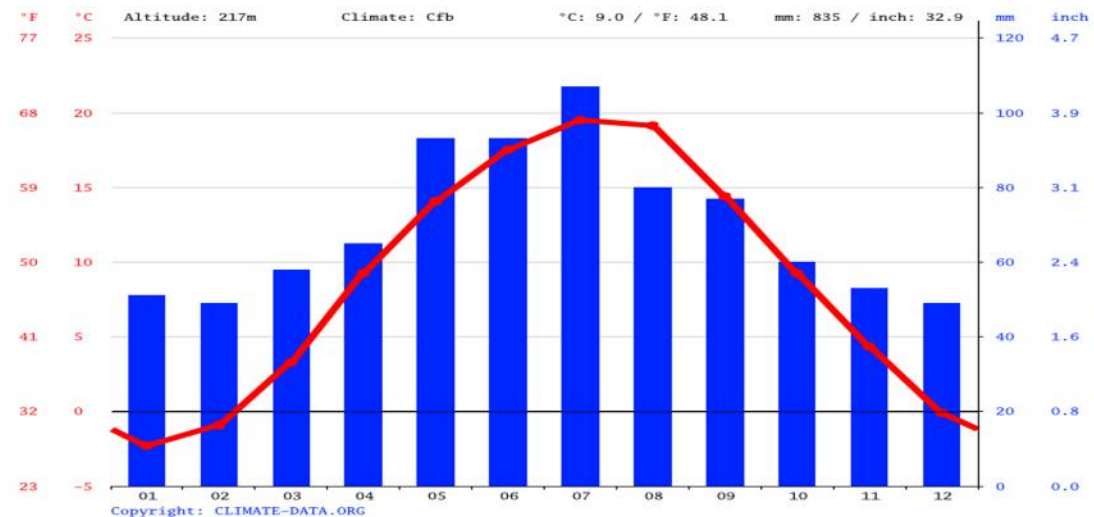


Krakow, Poland

More than 20M m² of public green areas with 140.000 trees, distributed among 4300 sites.

Care and management carried out by ZZM, a department of the City of Krakow, with support of external companies and professionals.

Climate zone Cfb (Koppen)





Comune di **Rimini**

Anthea 

Rimini, Italia

More than 2,5M m² of public green areas with 50.000 trees, distributed among 1000 sites.

Care and management carried out by Anthea, a public owned company of the City of Rimini and 4 other municipalities, with support of external companies and professionals.

Climate zone Cfa (Koppen)

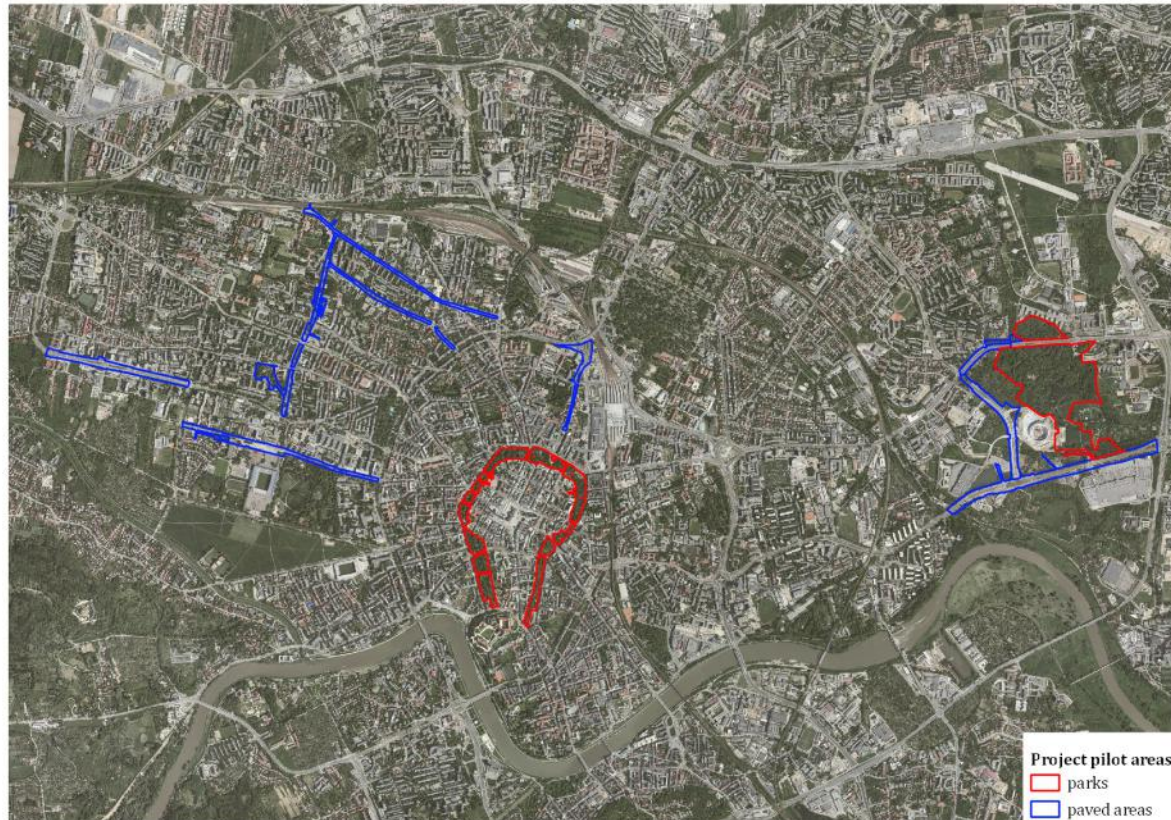


<https://en.climate-data.org/europe/italy/emilia-romagna/rimini-1176/#climate-graph>



The pilot areas

Kraków (PL): 500 ha



Rimini (IT): 250 ha



The studied species

Kraków (PL): 500 ha



Norway maple
Acer platanoides



Horse chestnut
Aesculus hippocastanum



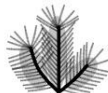
European ash
Fraxinus excelsior



Rowan
Sorbus aucuparia



Little-leaf linden
Tilia cordata



Austrian pine
Pinus nigra



Pedunculate oak
Quercus robur



Black poplar
Populus nigra



European white elm
Ulmus laevis



White dogwood
Cornus alba

Rimini (IT): 250 ha



Platano
Platanus x acerifolia



Ippocastano
Aesculus hippocastanum



Tiglio
Tilia x europaea



Ligustro lucido
Ligustrum lucidum



Pino domestico
Pinus pinea



Farnia
Quercus robur



Acero americano
Acer negundo



Pioppo nero
Populus nigra



Leccio
Quercus ilex



Lauroceraso
Prunus laurocerasus



臺北市政府
Taipei City Government



國立中央大學
National Central University

Taipei, Taiwan

The National Central University of Taiwan decided to participate to the project with its own budget and to use as a pilot site Daan Park in Taipei City.

Main results from Taiwan

The National Central University of Taiwan worked on the effect of typhoons on urban green areas in Taiwan.



Urban Forestry & Urban Greening

Volume 63, August 2021, 127191



Evaluation of urban greenspace vulnerability to typhoon in Taiwan

Kim-Anh Nguyen ^{a, b, c}, Yuei-An Liou ^a, Trong-Hoang Vo ^{a, b}, Dao Dinh Cham ^{b, c}, Hoang Son Nguyen ^d

Pre-project situation



GREENSPACES

Existing Platform to manage urban
green areas of the two cities:

Inventory of green areas including trees,
VTA management, job management,
playgrounds and inspections, etc.

CENSUS



MAINTENANCE



GREEN
SPACES

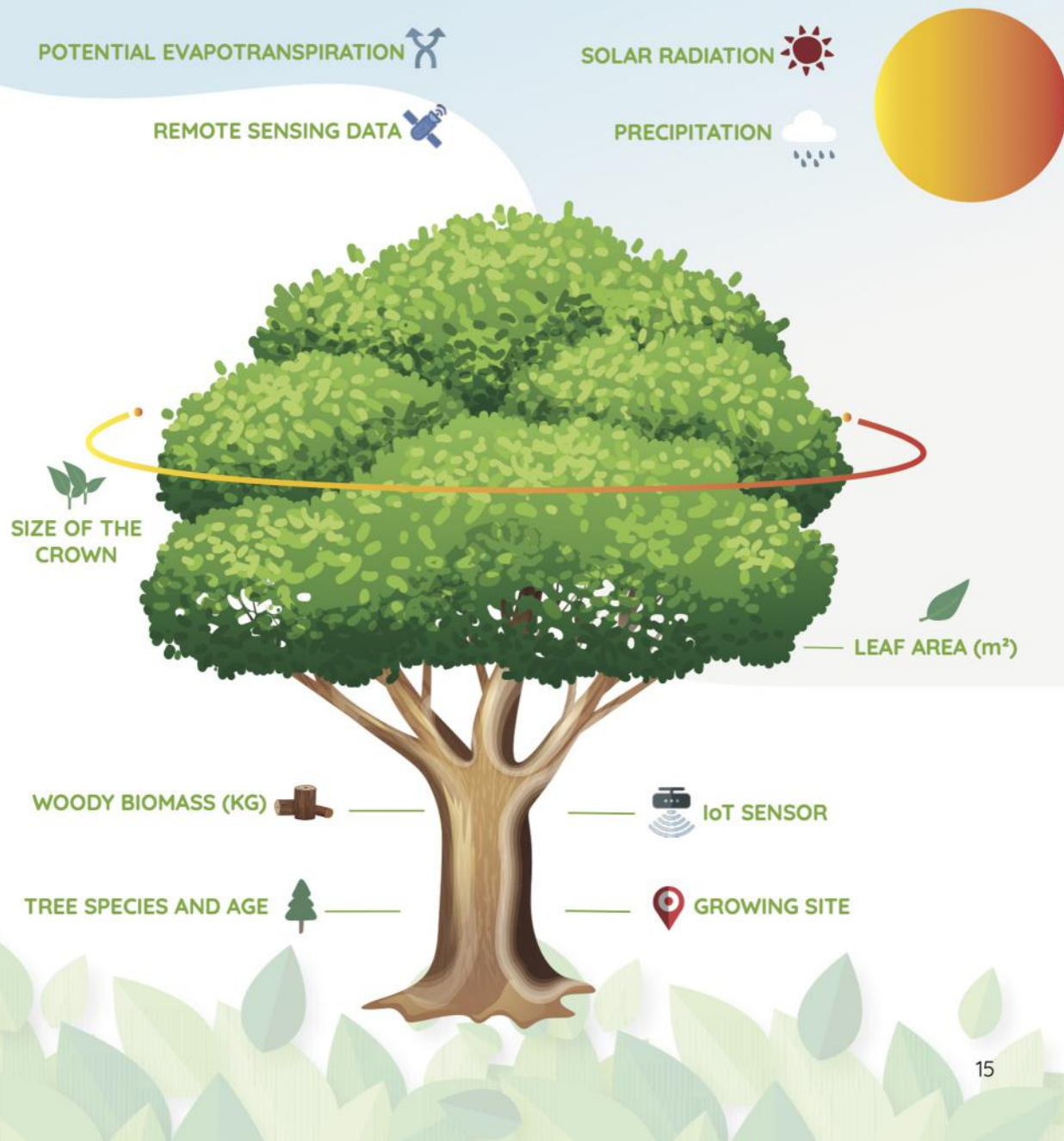


OPERATORS



CITIZENS

The research part



Scientific activities

Carried out by the two partners University of Milano and ProGea 4D with the support of CISMA.

In this presentation we will concentrate on software developments based on scientific research and tests on pilot sites.

Scientific results will be presented by Alessio Fini

How Trees Improve Cities: CO₂ Uptake, Cooling, Air Quality Amelioration

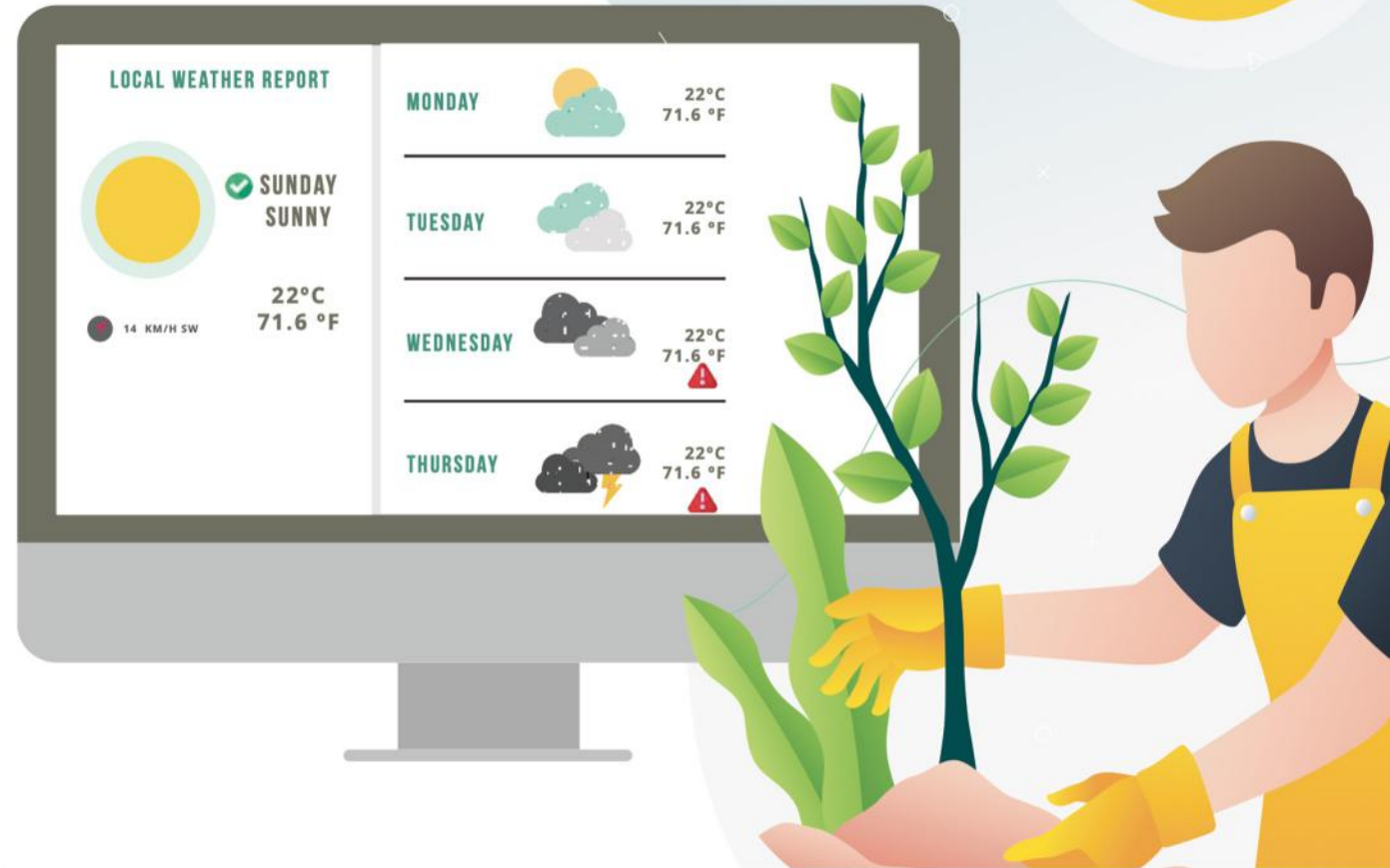
Wednesday 14/09/2022

Breakout session 1:30 pm - 1:55 pm

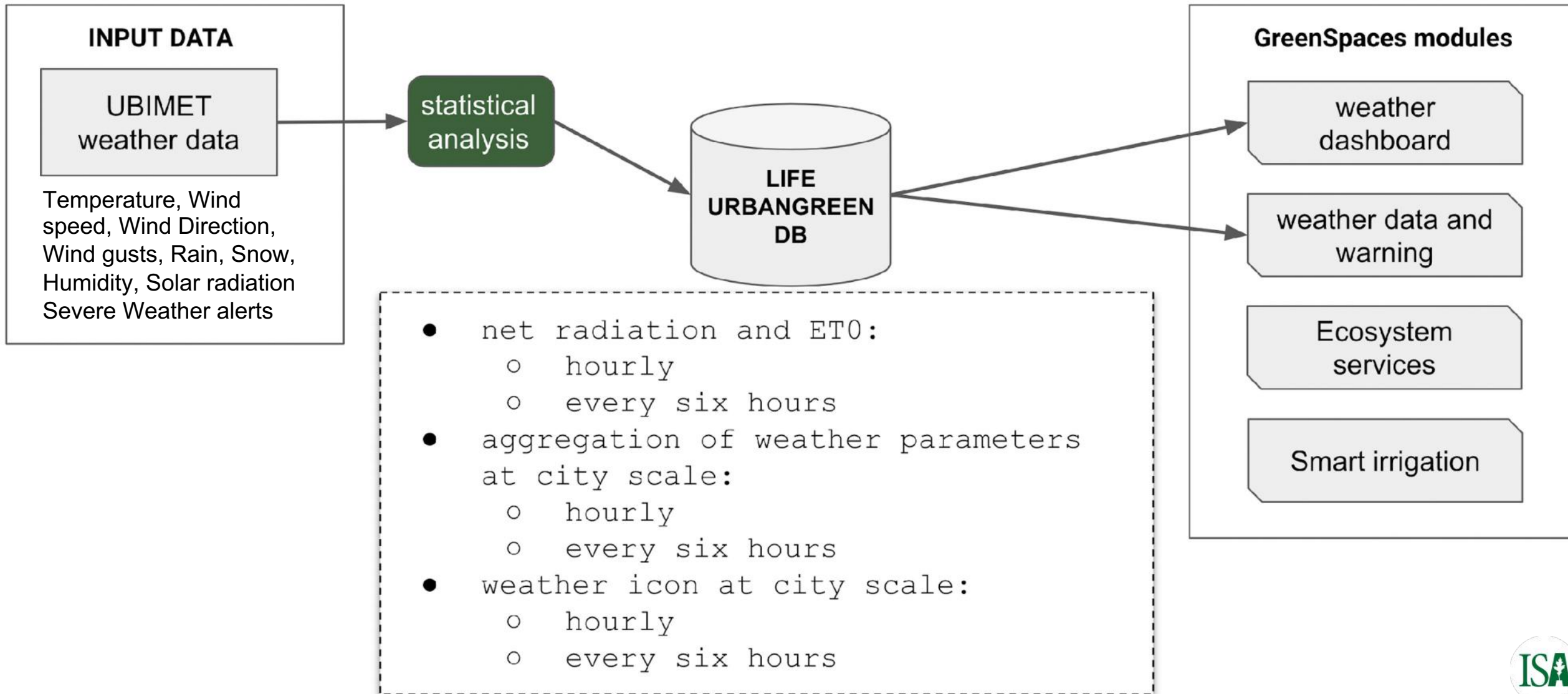
Room High Live 2

The software tools developed

Meteo dashboard and severe weather alerts



Weather data management



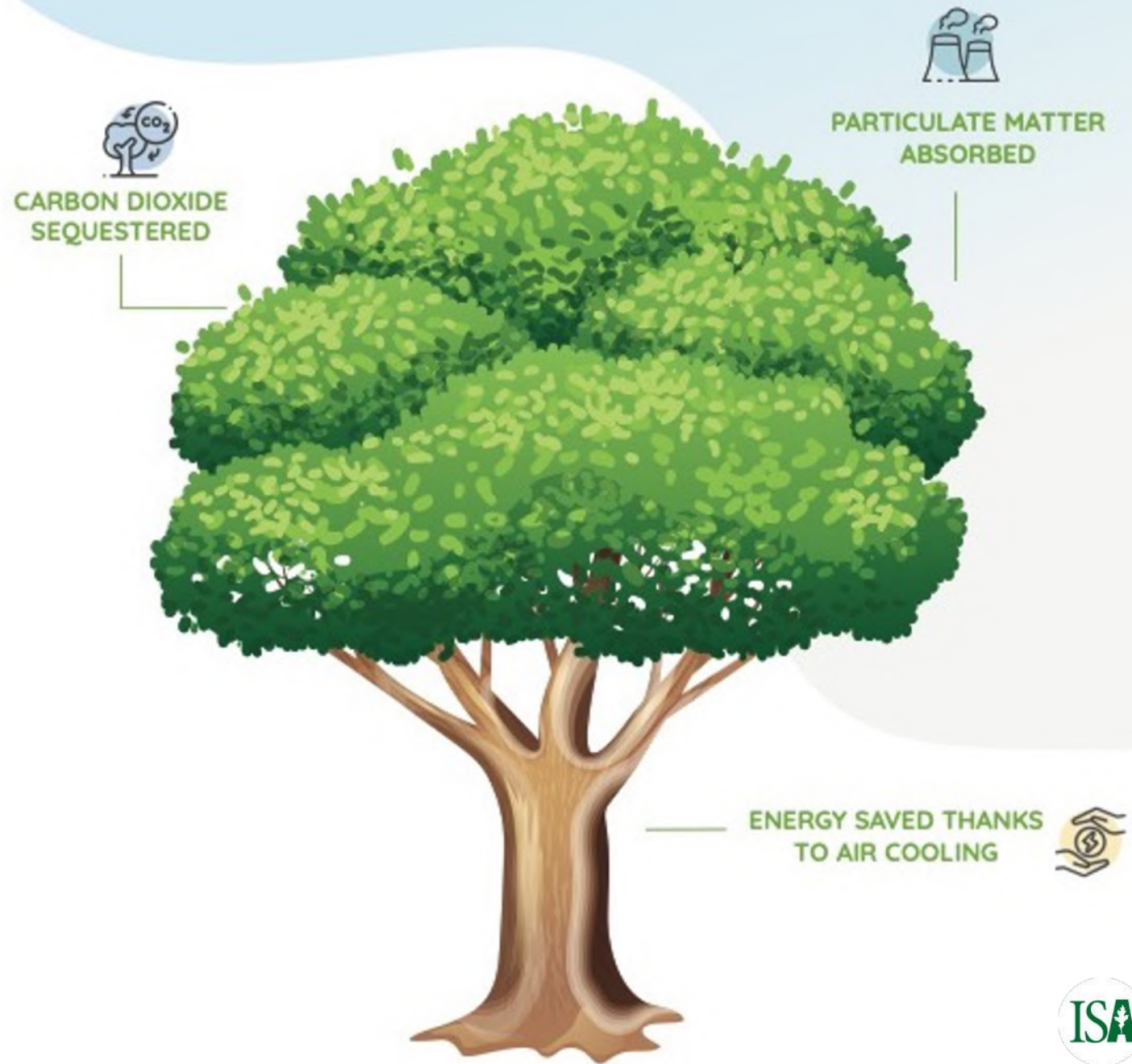
Weather dashboard



Severe weather alerts



Calculation of benefits of trees



Measurement campaigns

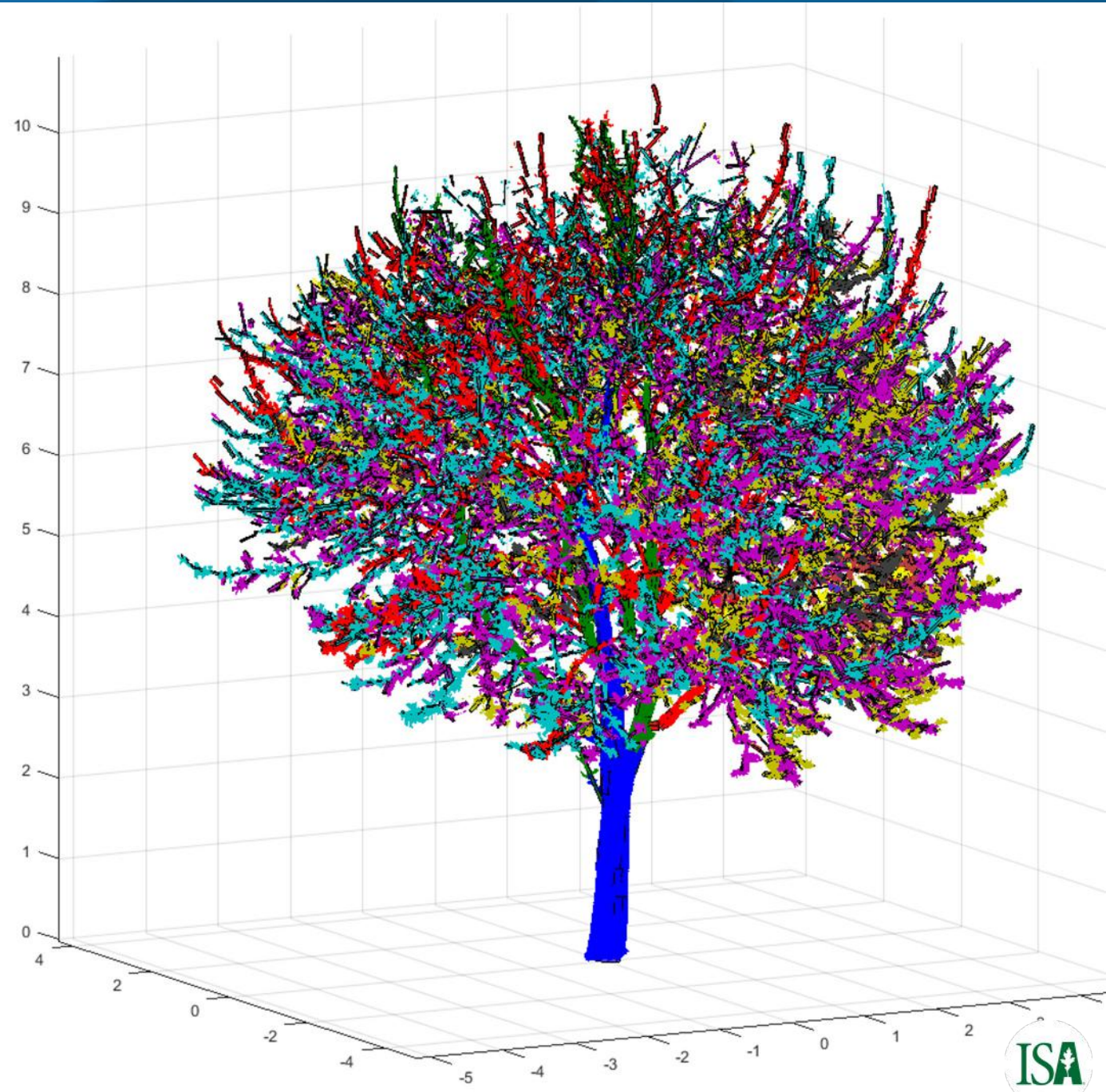
- 500 trees in Rimini and Krakow
- Four growing seasons (2018-2021)
- 17 species (10 Rimini, 10 Krakow, 3 common)
- more than 50% of the tree population of the two cities
- Leaf transpiration was measured to derive CO₂ adsorption and water transpiration
- LAI was measured by means of radiometric method



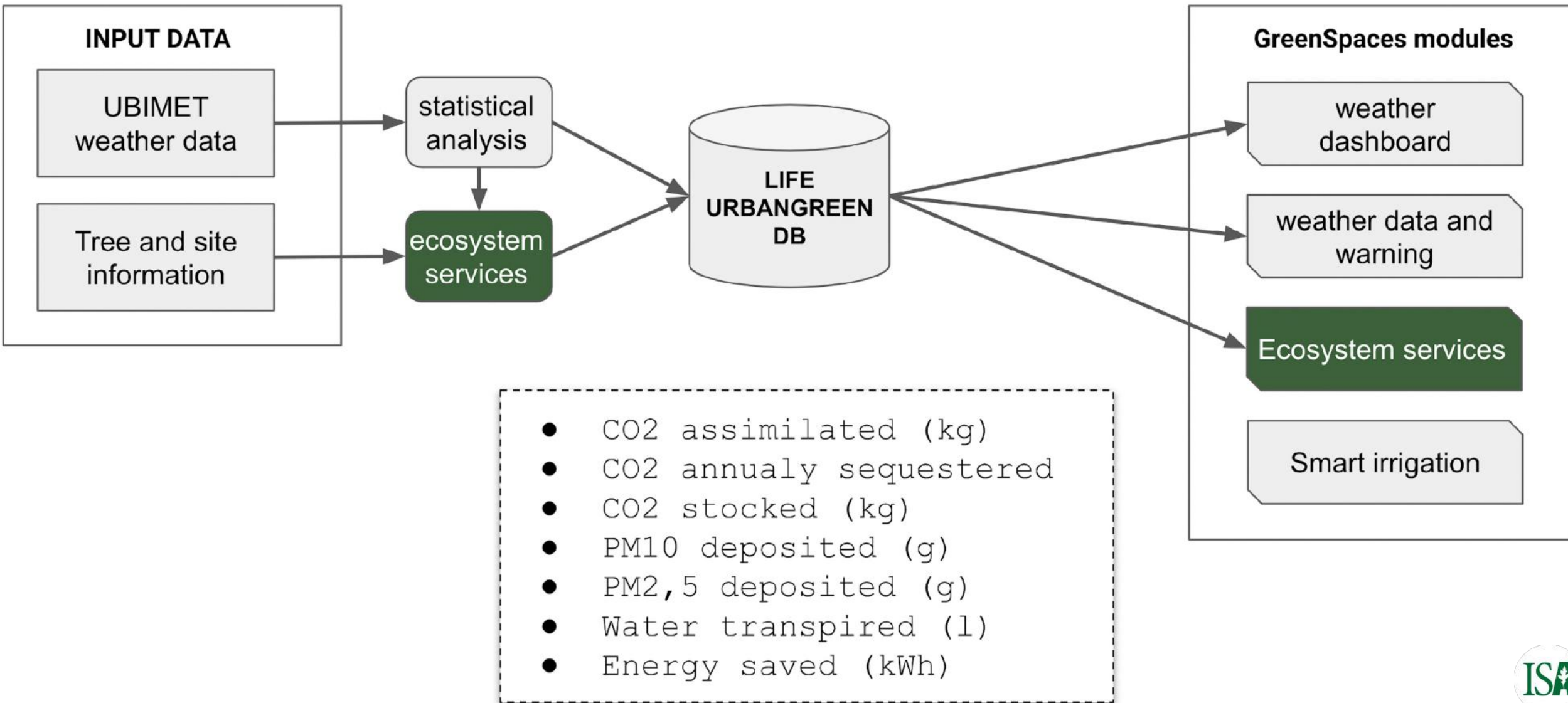
LiDAR TLS surveys

Accurate LiDAR measurement on selected trees was used to derive trunk volume, total leaf area and its distribution at different heights.

In addition, leaf samples were collected and analyzed in laboratory for deposition of pollutants (PM_{10} , $PM_{2.5}$).



Ecosystem services calculation



Tree benefits

Greenspaces - Ecosystem Services

krakow.r3gis.com

Administrator

General

Jobs

Life Urbangreen

Weather Dashboard

Weather warning

Weather data

TreeTalker

TT Cloud

Smart Irrigation

Ecosystem Services

Treesat

Airly

Lansitec

Irrigation scheme

Costs

Configuration

Users

Hide menu

Taxonomy

CO2 absorbed (kg)

CO2 annually sequestered (kg)

CO2 stocked (kg)

PM10 deposited (g)

PM2,5 deposited (g)

Water transpired (l)

Acer platanoides 'Drummondii' (Norway maple 'Drummondii')

1.10

36.45

125.10

0.71

0.17

69.10

Acer platanoides 'Faassen's Black' (Norway maple 'Faassen's Black')

1.68

58.87

291.11

1.08

0.26

105.40

Acer platanoides 'Globosum' (Acero globoso)

2.47

81.30

628.28

1.59

0.38

154.85

Acer platanoides 'Globosum' (Acero globoso)

1.57

53.27

255.69

1.02

0.24

98.78

20/07/20221.001 - Planty Krakowskie001435Acer platanoides (Norway maple)

13.90

271.94

6,562.04

7.73

1.84

0.01

924.39

20/07/20221.001 - Planty Krakowskie001437Acer platanoides (Norway maple)

16.10

311.19

8,798.19

8.95

2.13

0.01

973.93

20/07/20221.001 - Planty Krakowskie001438Acer platanoides (Norway maple)

16.19

311.19

8,898.99

9.00

2.14

0.01

1,057.95

20/07/20221.001 - Planty Krakowskie001524Acer platanoides (Norway maple)

2.57

86.91

682.27

1.66

0.39

0.00

751.37

20/07/20221.001 - Planty Krakowskie001526Acer platanoides (Norway maple)

6.86

131.77

1,597.39

3.81

0.91

0.00

870.03

20/07/20221.001 - Planty Krakowskie001527Acer platanoides (Norway maple)

9.24

176.62

2,897.81

5.14

1.22

0.00

875.00

20/07/20221.001 - Planty Krakowskie001528Acer platanoides (Norway maple)

21.59

417.73

15,820.43

12.00

2.85

0.01

1,166.66

20/07/20221.001 - Planty Krakowskie001531Acer platanoides (Norway maple)

15.37

299.98

8,018.44

8.54

2.03

0.01

830.58

20/07/20221.001 - Planty Krakowskie001532Acer platanoides (Norway maple)

9.60

0

3,131.27

5.34

1.27

0.00

519.03

20/07/20221.001 - Planty Krakowskie001613Acer platanoides (Norway maple)

15.51

0

8,166.05

8.62

2.05

0.01

838.19

20/07/20221.001 - Planty Krakowskie001615Acer platanoides (Norway maple)

20.80

406.51

14,687.38

11.56

2.75

0.01

1,124.11

20/07/20221.001 - Planty Krakowskie001620Acer platanoides (Norway maple)

11.86

0

4,775.03

6.59

1.57

0.00

640.95

20/07/20221.001 - Planty Krakowskie001631Acer platanoides (Norway maple)

15.97

0

8,654.30

8.87

2.11

0.01

862.88

20/07/20221.001 - Planty Krakowskie001632Acer platanoides (Norway maple)

1.99

64.48

410.47

1.29

0.31

0.00


125.16


Legend: Living treeDead treeTree stumpFelled Treebeing processed


Items per page 251 - 25 of 1534Page 1 / 62


Tree benefits


Benefits extended to other species with similar behaviour:

**Norway maple**
Acer platanoides

**10,969** ⓘ
Number of trees

**3/10** ⓘ
CO₂ assimilation

**4/10** ⓘ
Air quality amelioration

**2/10** ⓘ
Cooling by transpiration

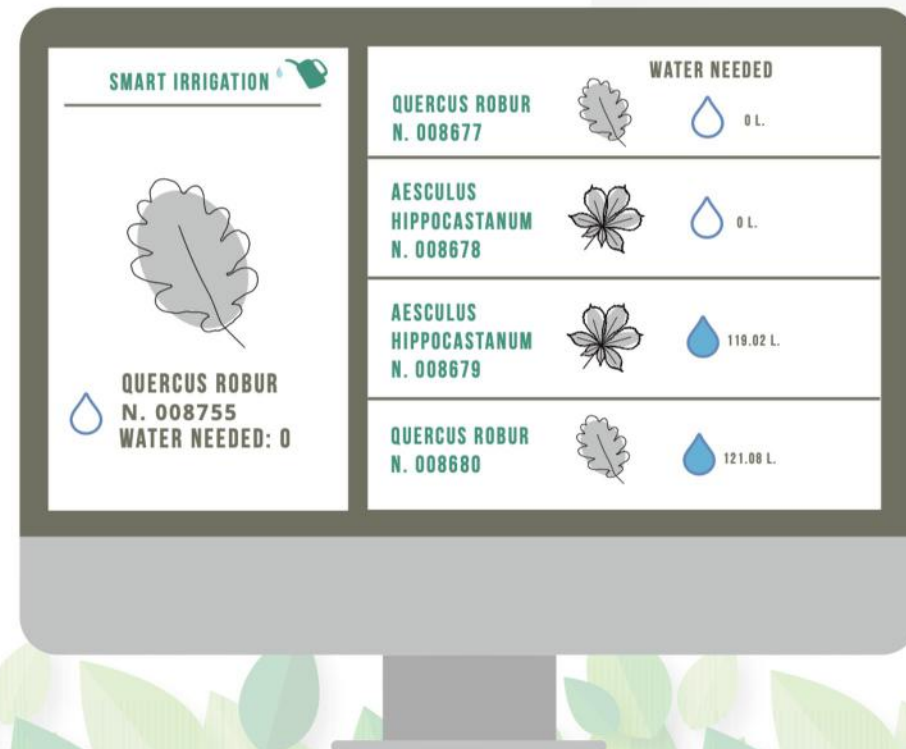
Description

Norway maple is a native species in Europe, widespread from Spain to Scandinavia. It is a fast-growing deciduous species that can grow up to 25 m tall at maturity and develop a rounded, broad, or pyramidal canopy, depending on the cultivar used. It can live up to 75 years in cities, but the lifespan is often shortened by stress factors, like fungi. Palmate leaves are opposite on shoots and usually have 5 lobes. Some cultivars show permanently or transiently red leaves. The yellowing of leaves during fall is extremely attractive. Flowers are yellow and flowering occurs in April- early May, before the foliation. The fruit is a di-samara, with a broad angle (>120°C) between the samaras. Grows well in mild shade. It is extremely hardy (up to -40°C) and well adapted to poor and compacted soils in the pH range 5.5-8.0. It is extremely easy to transplant.

Assimilated species

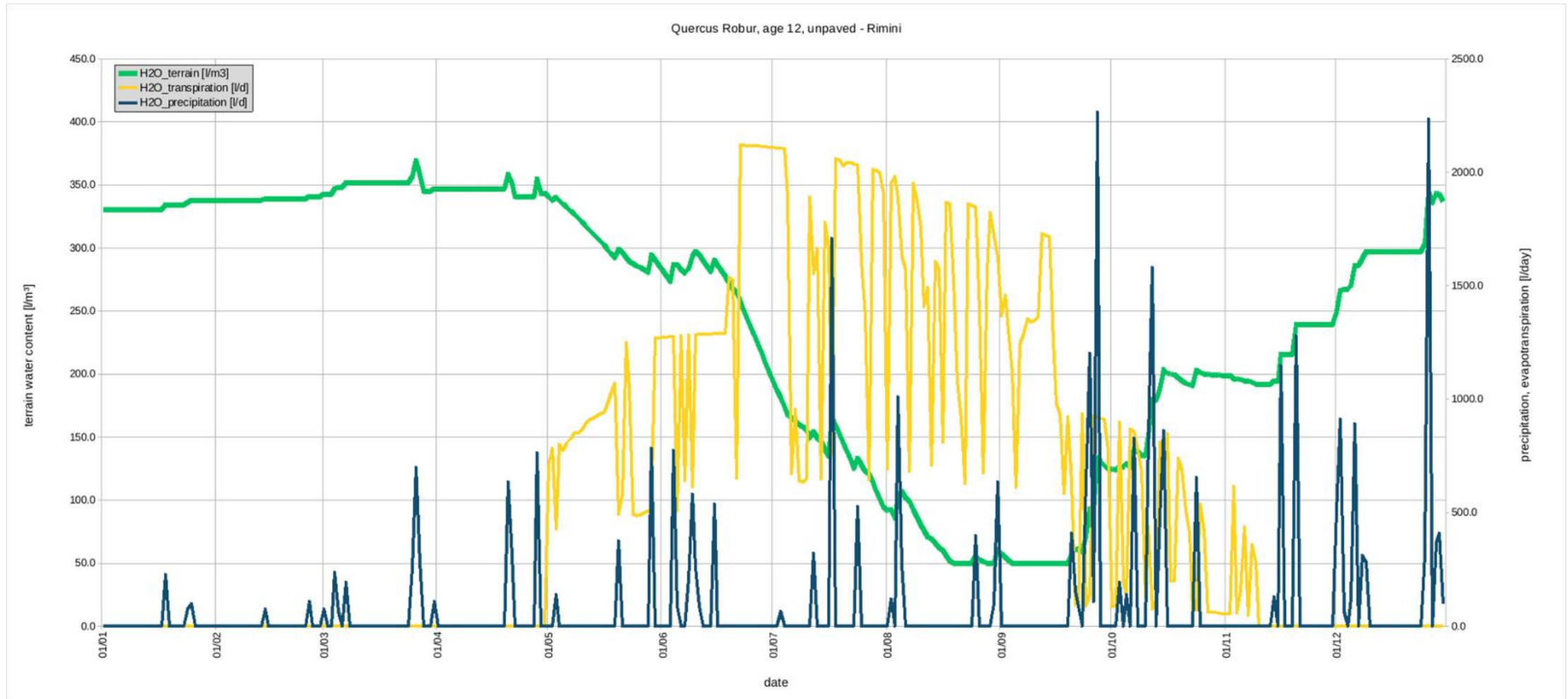
- Acer platanoides 'Drummondii'
- Acer platanoides 'Faassen's Black'
- Acer platanoides 'Globosum'
- Acer platanoides 'Princeton Gold'
- Acer platanoides 'Royal Red'
- Acer platanoides 'Schwedleri' Acer sp.
- Acer pseudoplatanus
- Acer pseudoplatanus 'Atropurpureum'
- Acer pseudoplatanus 'Aureum'
- Acer pseudoplatanus 'Erectum'
- Acer pseudoplatanus 'Leopoldii'
- Acer pseudoplatanus 'Negenia'
- Acer pseudoplatanus 'Purpureum'
- Acer pseudoplatanus 'Rotterdam' Acer rubrum
- Acer rubrum 'Red Sunset'

Smart irrigation tool

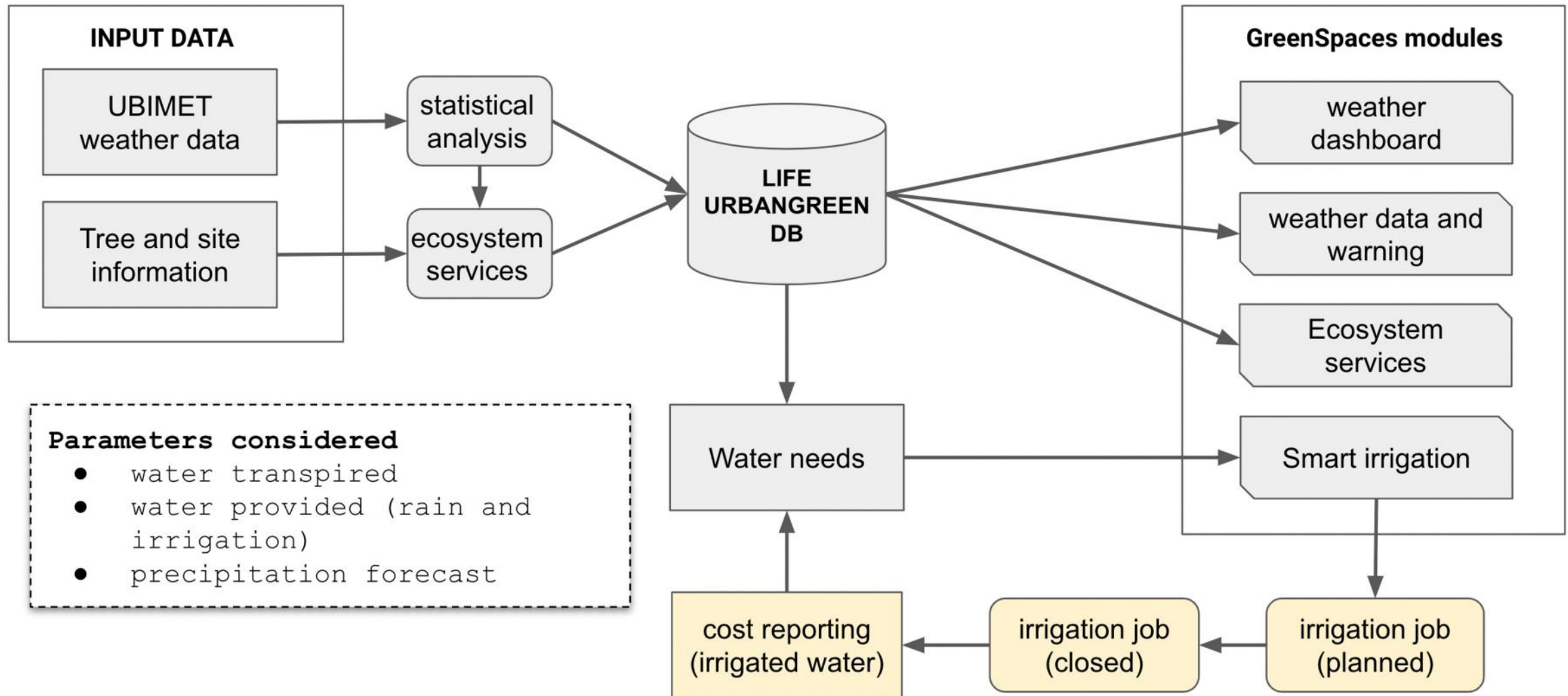


Smart irrigation

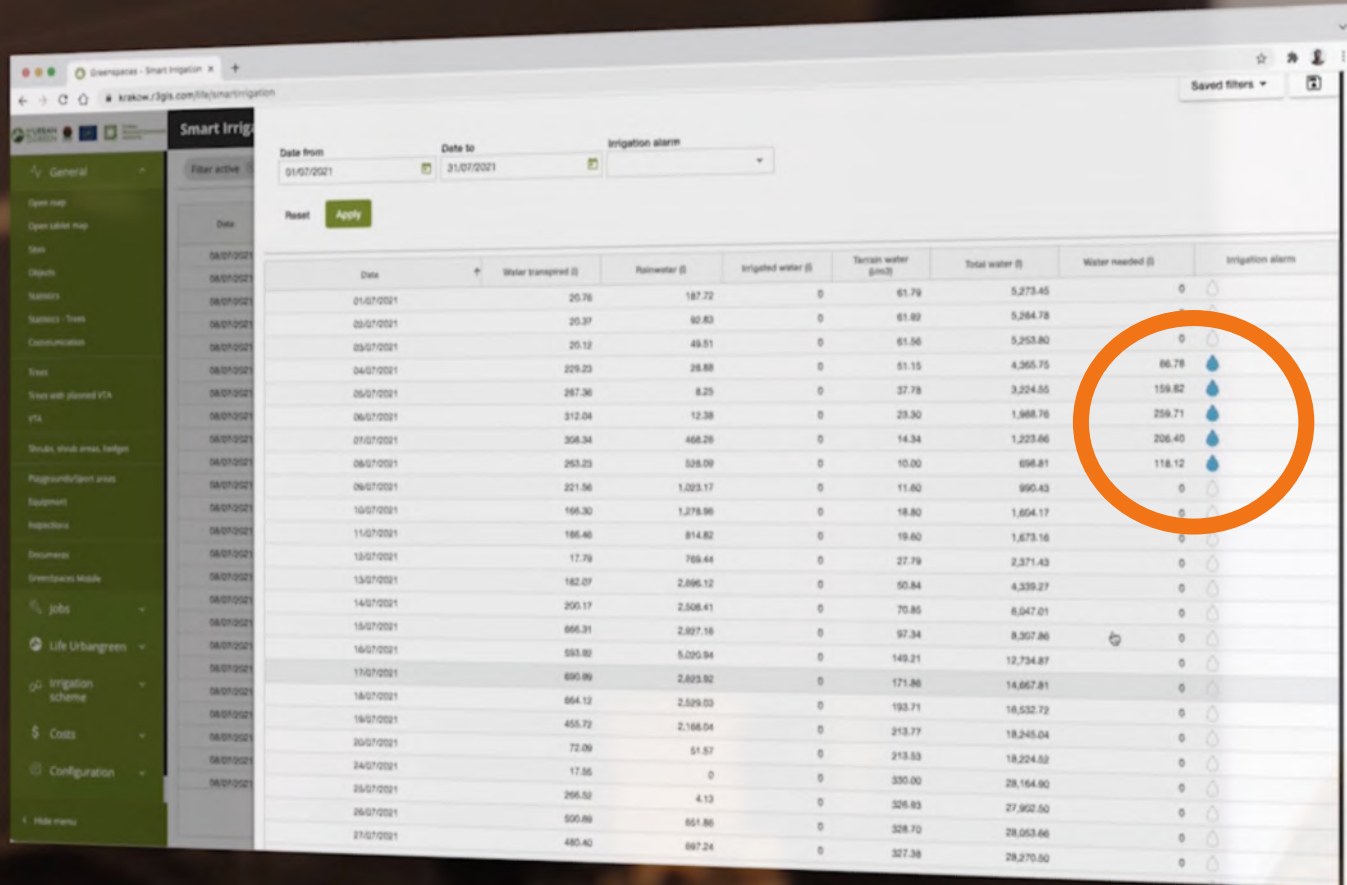
With transpiration, precipitation and irrigation GreenSpaces calculates the water available to the tree and when a tree needs water



Smart irrigation



Smart irrigation



The image shows a woman looking at a computer screen displaying a smart irrigation software interface. The interface has a sidebar with various menu items and a main table showing irrigation data. A red circle highlights a specific row in the table.

Smart Irrigation Software Interface

Table Columns:

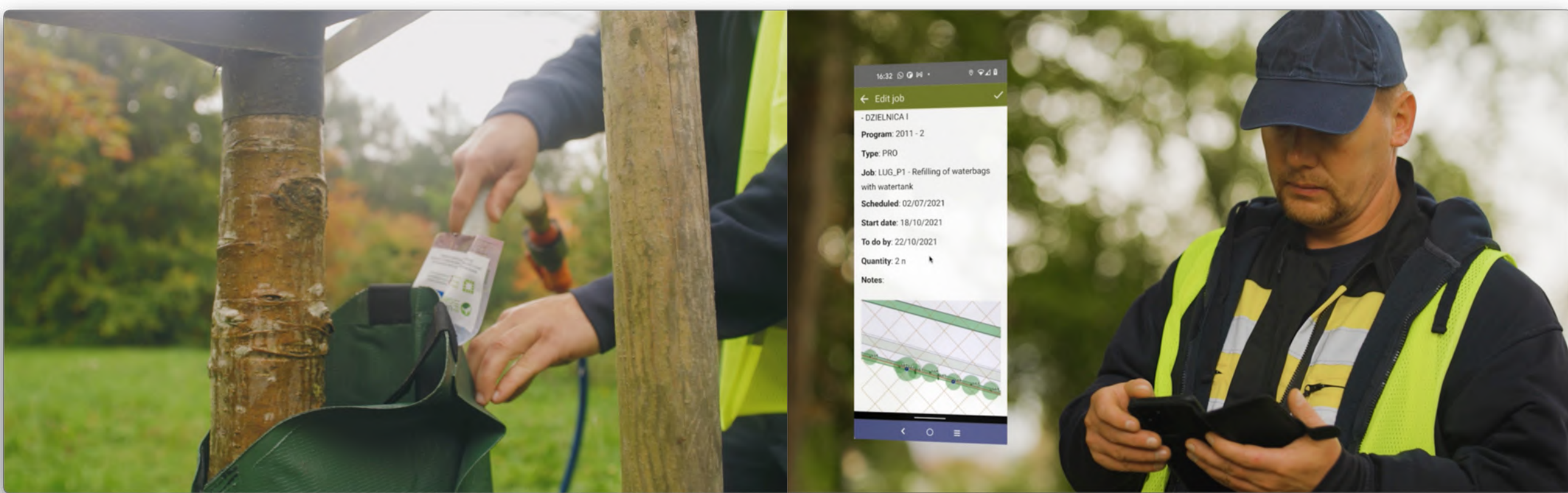
- Date
- Water transpired (l)
- Rainwater (l)
- Irrigated water (l)
- Terrain water (mm)
- Total water (l)
- Water reached (l)
- Irrigation alarm

Highlighted Row (Date: 06/07/2021):

Date	Water transpired (l)	Rainwater (l)	Irrigated water (l)	Terrain water (mm)	Total water (l)	Water reached (l)	Irrigation alarm
06/07/2021	86.78	0	0	61.79	5,273.45	0	🔴
06/07/2021	159.82	0	0	61.82	5,284.78	0	🔴
06/07/2021	259.71	0	0	61.56	5,253.80	0	🔴
06/07/2021	206.40	0	0	61.15	4,365.75	0	🔴
06/07/2021	118.12	0	0	37.78	3,224.55	0	🔴

Smart irrigation

Based on the calculations of the smart irrigation tool trees are watered and the delivered amount of water is recorded.

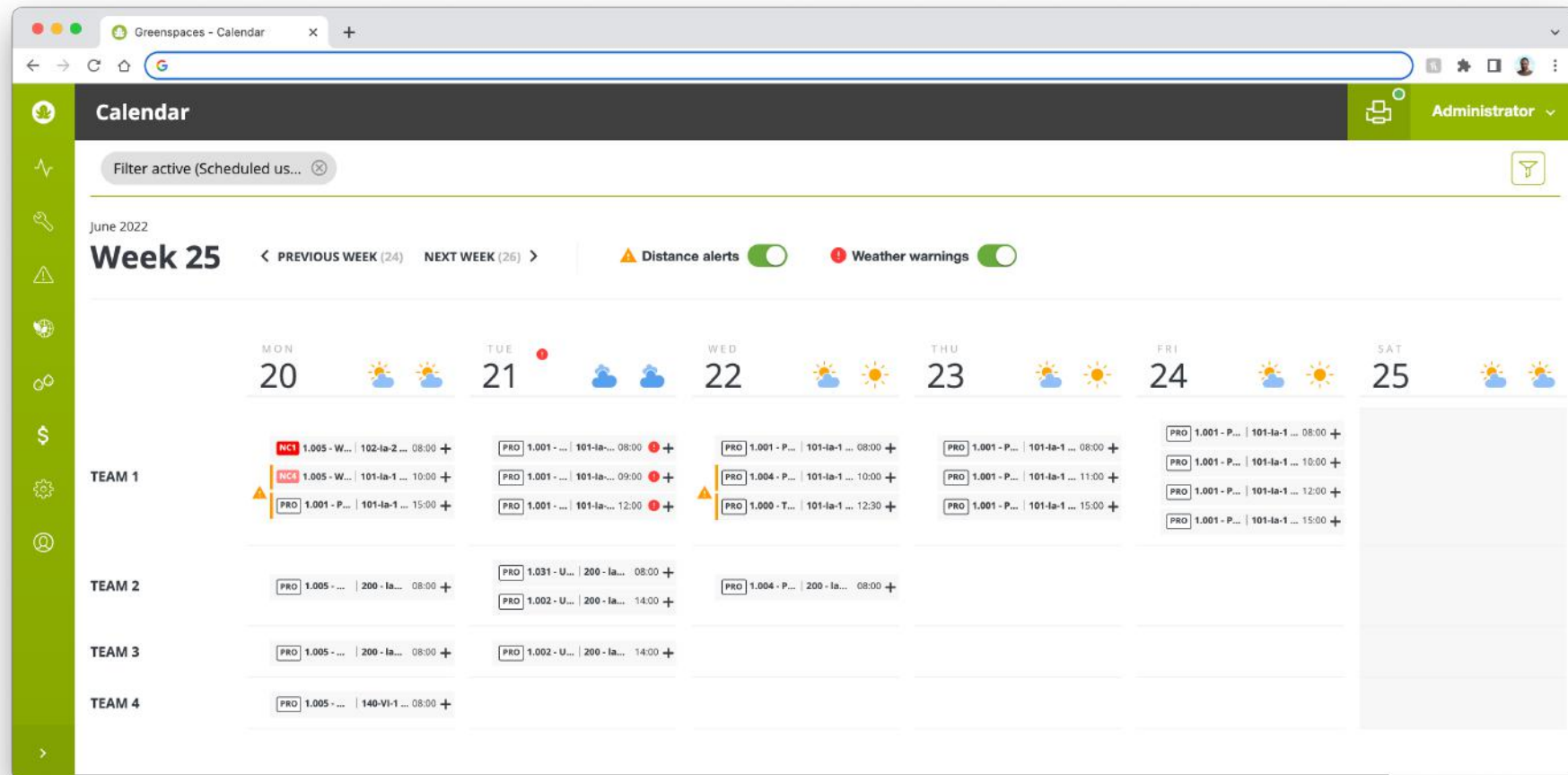


Efficient planning of care and maintenance activities



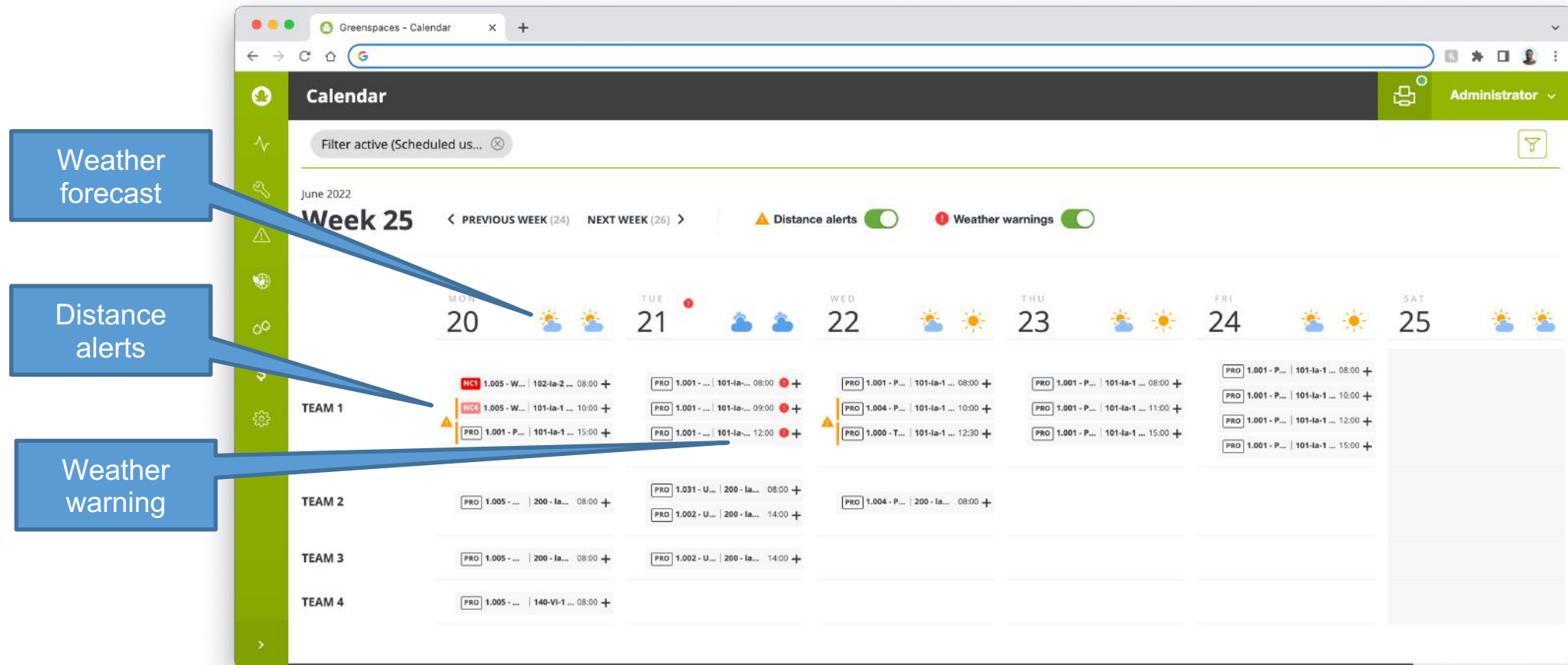
Smart job scheduling

In order to make maintenance more efficient and reduce the carbon footprint, tools have been developed to schedule jobs considering weather forecast and distance between sites.



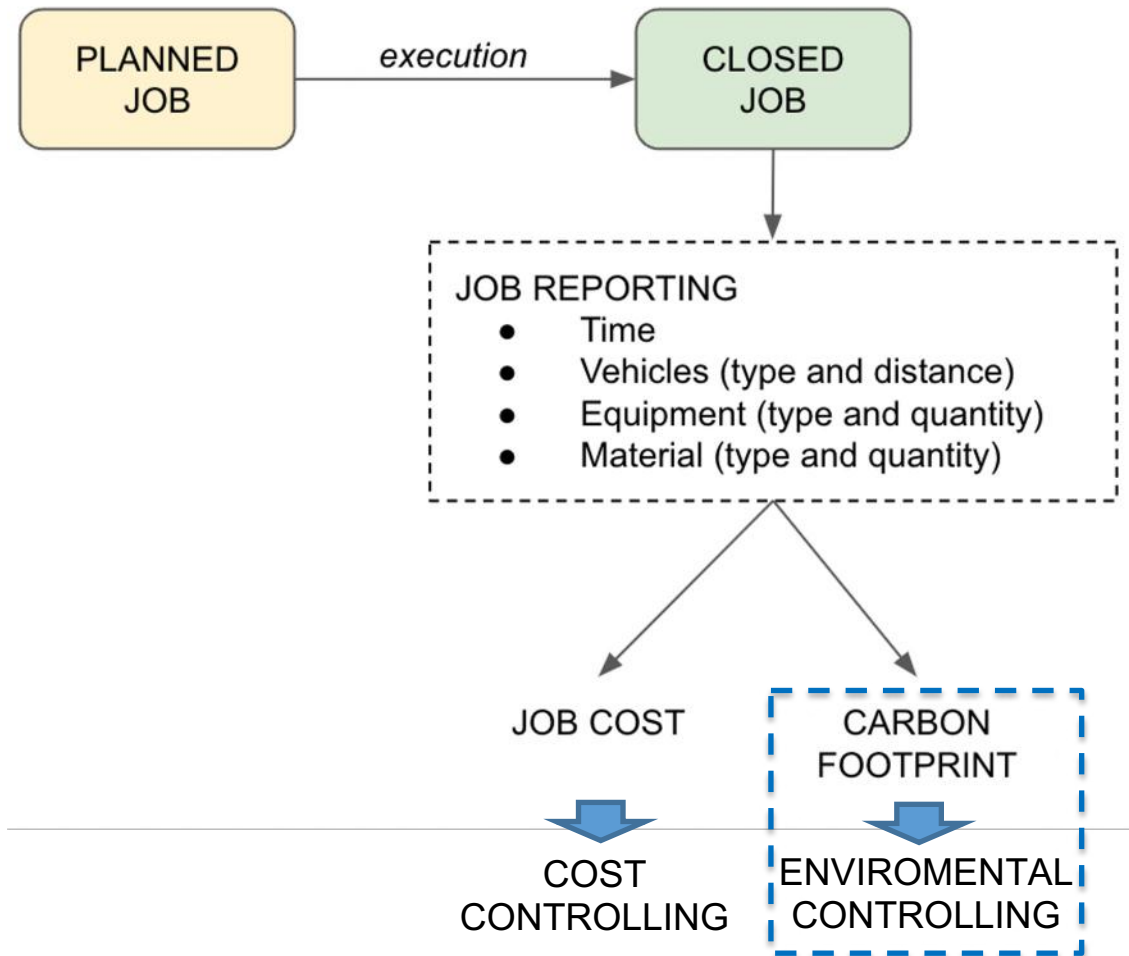
Smart job scheduling

In order to make maintenance more efficient and reduce the carbon footprint, tools have been developed to schedule jobs considering weather forecast and distance between sites.



Cost controlling

Tools to record the effort and resources used to close a job and cost controlling by cost center -> reduce carbon footprint



Change job

Confirm status

Status *
Done

Comment

Photo
Add picture

Costs
Water with tank - 50 l

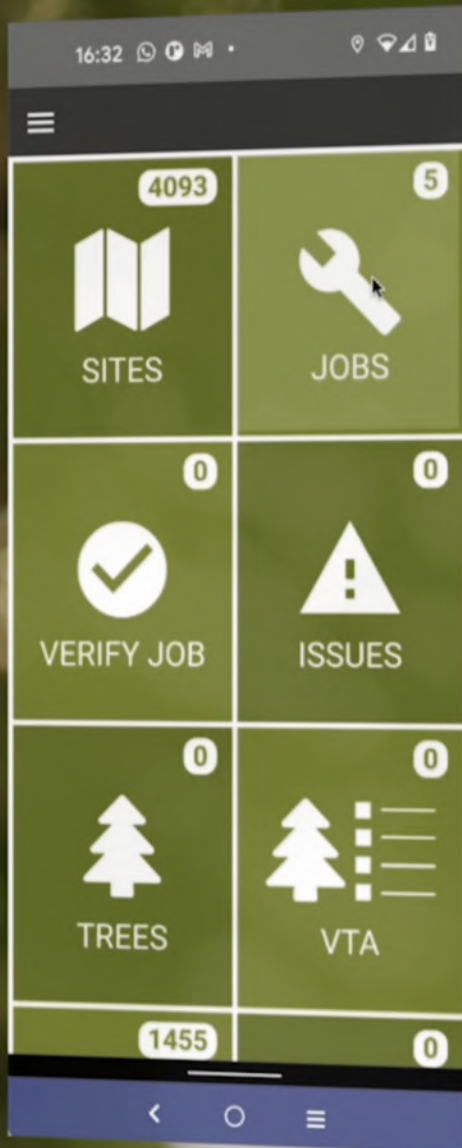
Details job
Site: 1.001 - Planty Krakowskie
Object details: 008719 - Acer platanoides
Scheduling: 2011 - 2

Edit cost

Category *
Water

Material/Tool *
Water with tank

Quantity *
50



Integration of IoT sensors



Environmental sensors

Several types of sensors were integrated into GreenSpaces to acquire environmental data and monitor variables as: air temperature, humidity and pollutants, trees radial growth, sap flow, stem position, light passing through the crown, etc.

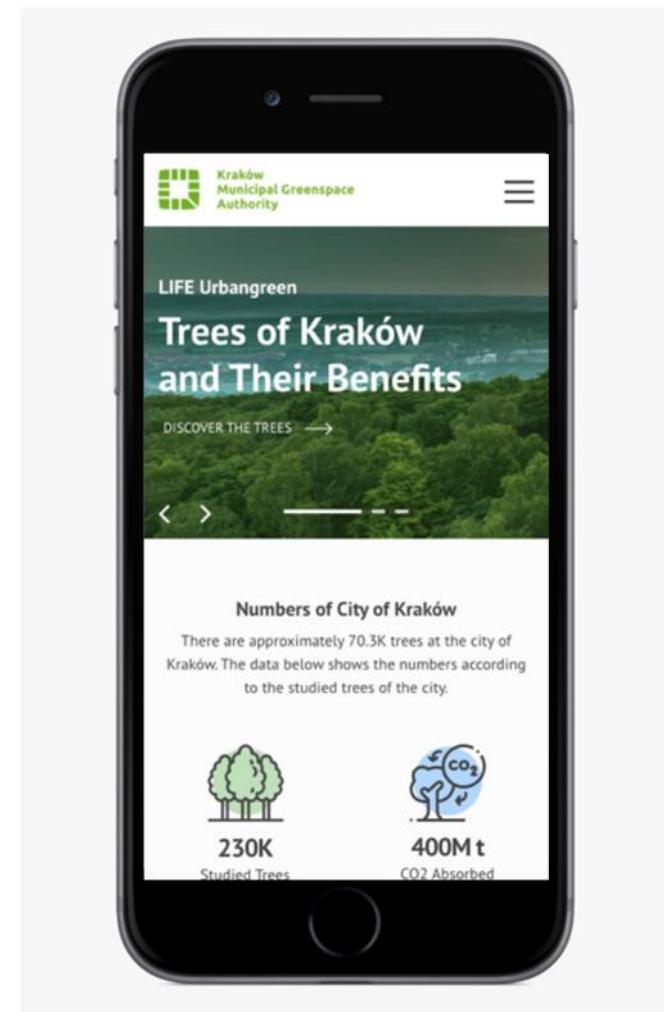
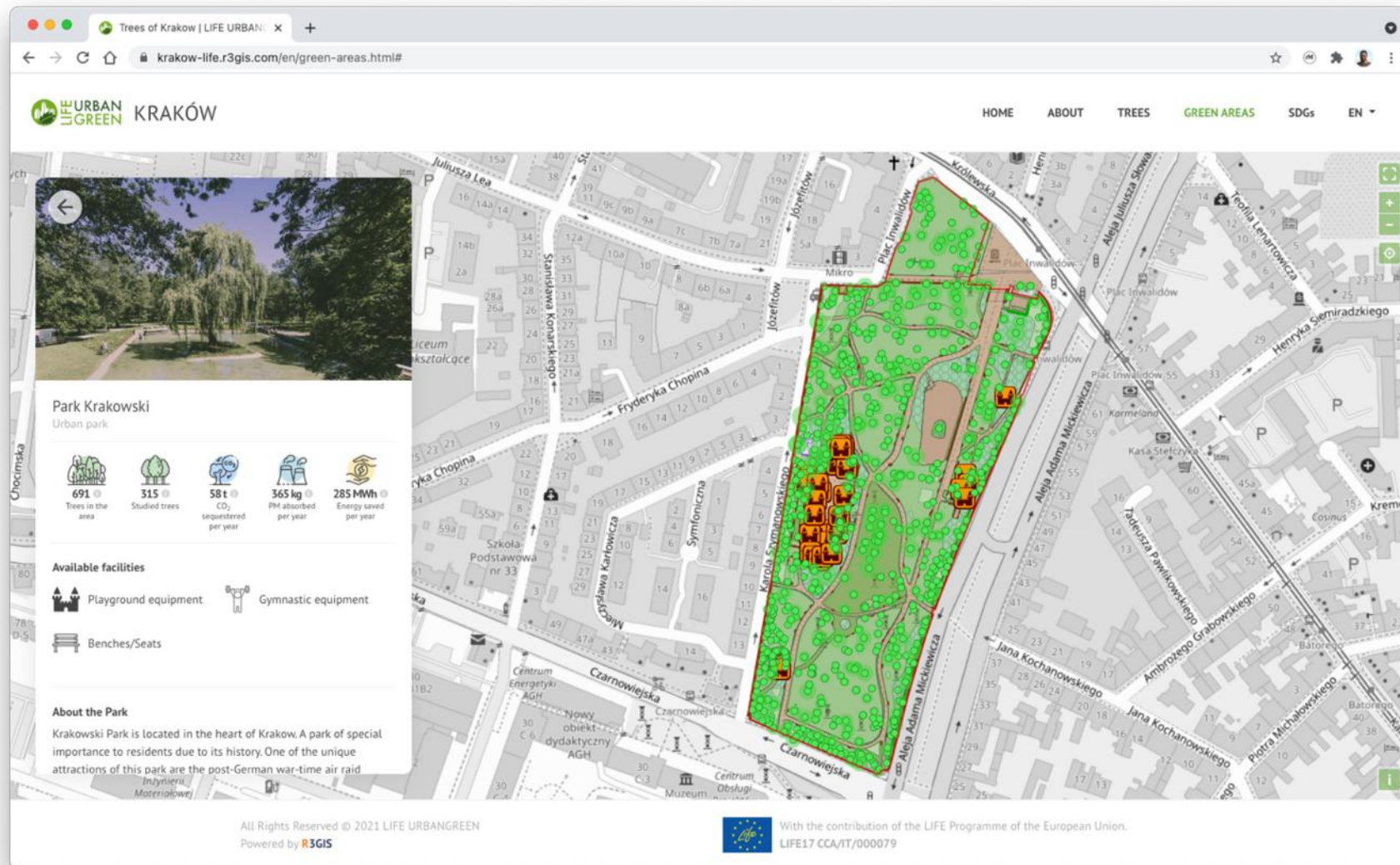
Further activities are under way to use the sensor data to calibrate ecosystem services algorithms.



Engagement of citizens



Public portal



Public portal

Life update of green area census, tree inventory and ecosystem services on a daily basis.

Trees in this area

Norway maple

Acer platanoides

Site name

Park Krakowski

Tree number

038484

Height

15-20 m

Crown diameter

11 m

Stem circumference

152 cm

Tree benefits

13 kg
CO₂ absorbed today

8 g
PM absorbed today

2 kWh
Energy saved today

YEAR

TODAY

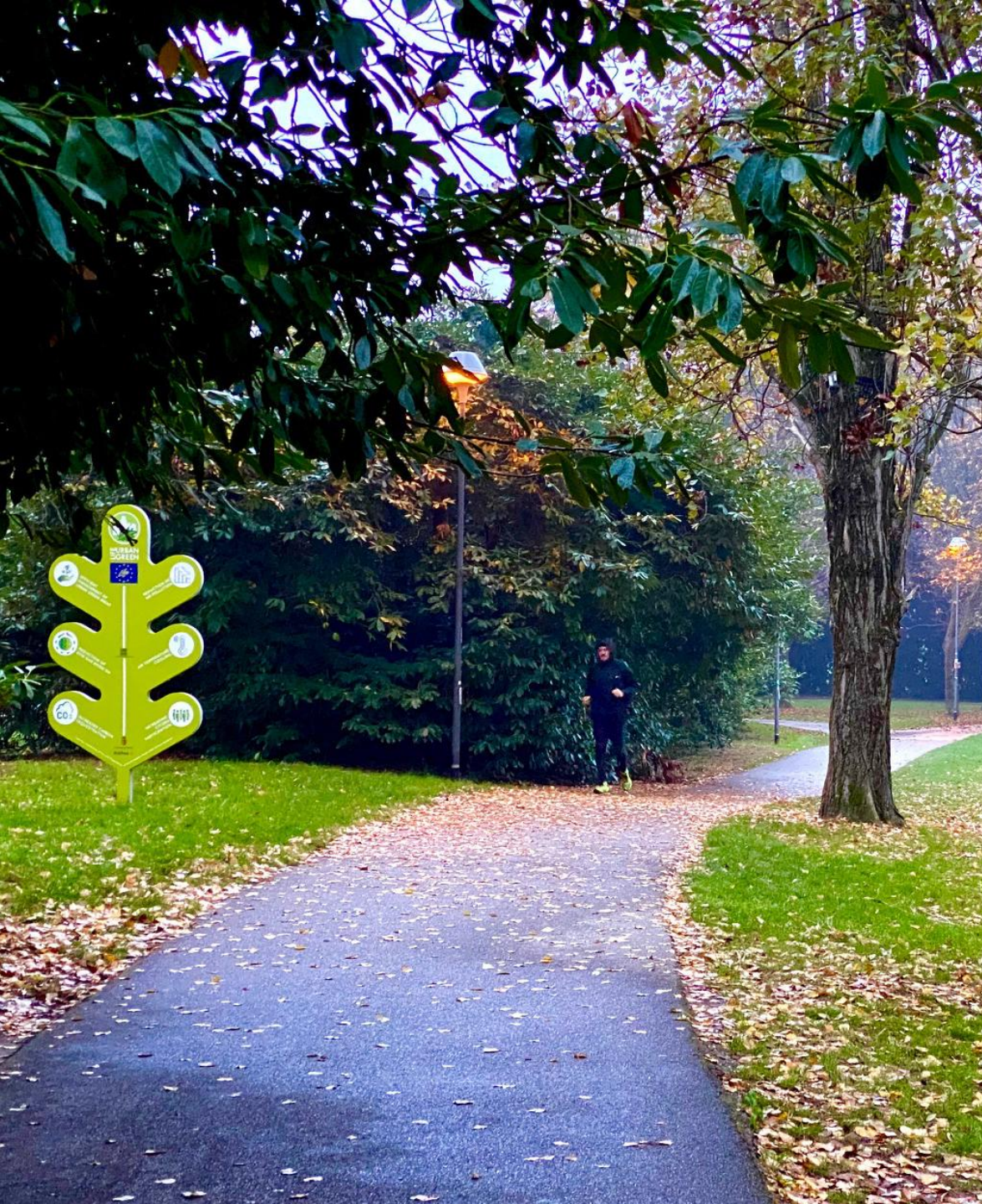
26.590
Studied trees

1.984 t
CO₂ sequestered
per year

9.410 kg
PM absorbed
per year

12.125 MWh
Energy saved
per year

Testing and demonstration on pilot sites



Pilot and control sites

The study areas in the two cities were divided into Pilot and Control areas.

Similar trees were selected in pilot and control areas and were measured during the first year as a baseline.

In Pilot areas best practices were applied:

- Target pruning, according to ETW standards
- Mulching on trees
- Soil aeration on compacted soil around the trees
- Irrigation to trees according to the smart irrigation module

In control areas trees were treated as usual, without particular attention.

Best practices

In pilot areas best practices were applied to ensure optimal conditions and ecosystem services maximization

TARGET PRUNING (ETW)



MULCHING



TREE IRRIGATION



SOIL AERATION



Best practices

In pilot areas best practices were applied to ensure optimal growing conditions and ecosystem services maximization. Differences in ES provisioning were measured at the beginning of the project and two years after application of the best practices. Average values for all studied species are given.

City	Rimini (I)			Krakow (PL)		
Ecosystem services (pilot vs. control)	1 st year	2 years after imposition of treatment	Difference	1 st year	2 years after imposition of treatment	Difference
CO ₂ assimilation per tree (kg tree ⁻¹ day ⁻¹)	-2,4%	+21,9	+24,3%	-9,3%	+6,1%	+15,4%
PM ₁₀₋₁₀₀ per tree (g tree ⁻¹)	-5,7%	+14,9%	+20,5%	-17,8%	-5,3%	+12,5%
PM _{2.5-10} per tree (g tree ⁻¹)	-7,8%	+23,8%	+31,6%	-14,4%	-3,3%	+11,1%
PM _{0-2.5} per tree (g tree ⁻¹)	-24,4%	+9,5%	+33,8%	-19,3%	+0,5%	+19,9%

Outlook and conclusions

WWW.VERDEVALE.EU



VERDEVALE

Metodi innovativi per la gestione e valorizzazione
del verde urbano e dei servizi ecosistemici

Conclusions

- The tools developed have been tested in Rimini and Krakow and are now being applied to other cities.
- Through LIFE URBANGREEN only a few ecosystem services were addressed for a limited number of species. More research is required to extend the algorithms.
- In the Verdevale project we managed to extend measurements to selected shrub and hedge species. We are working on further opportunities.
- Further developments are going on to integrate and make use of IOT sensor data and of remote sensing data.

THANK YOU!

www.lifeurbangreen.eu

www.r3gis.com/greenspaces



Kraków
Municipal Greenspace
Authority

ProG^{4D}



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